

AMENDMENTS TO THE CLAIMS:

The following listing of claims replaces all prior versions of the claims.

1-25. (Canceled)

26. (Previously Presented) The crystalline silicon film forming method according to claim 33 , wherein an emission energy of said ion beam is in a range from 100eV to 1keV.

27. (Previously Presented) The crystalline silicon film forming method according claim 35 , wherein an emission energy of said ion beam is in a range from 500eV to 10keV.

28. (Previously Presented) The crystalline silicon film forming method according to claim 37 , wherein an emission energy of said ion beam is in a range from 500eV to 10keV.

29. (Previously Presented) The crystalline silicon film forming method according to claim 37 , wherein an emission energy of said ion beam is in a range from 2keV to 10keV.

30. (Previously Presented) The crystalline silicon film forming method according to claim 36 , wherein an emission energy of said ion beam is in a range from 500eV to 10keV.

31. (Previously Presented) The crystalline silicon film forming method according to claim 33 , wherein said film forming device employs a structure performing the film formation by plasma CVD.

32. (Original) The crystalline silicon film forming method according to claim 31, wherein the formation of the pre-film by said plasma CVD uses a mixture gas of a silicon-contained gas and a hydrogen gas as a gas for film formation.

33. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and forming the pre-film of the crystalline silicon film on the target surface of said substrate ~~in a first direction~~ over a length, in a first direction, of the target surface by said film forming device while emitting the ion beam to the target surface of said substrate from said ion source over the length in the first direction to form the pre-film having a crystallinity; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam over the length in the first direction for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film while moving the substrate in a linear second direction crossing the first direction;

wherein the method is conducted without dehydrogenation processing, and

wherein the energy beam is selected from the group consisting of a laser beam and an electron beam.

34. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and forming the pre-film of the crystalline silicon film on the target surface of said substrate by said film forming device while emitting the ion beam to the target surface of said substrate from said ion source ~~in the first direction~~ over a length, in a first direction, of the target surface to form the pre-film having a crystallinity; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film,

wherein said film forming device employs such a structure that can form said pre-film over a the length, in the first direction, of the target surface of said substrate, said energy beam irradiation device employs such a structure that can irradiate the target surface of said substrate over the length in the first direction with the energy beam, and

the intended crystalline silicon film can be successively formed by operating said film forming device to form said pre-film on the target surface of said substrate, and concurrently operating said energy beam irradiation device to irradiate the formed pre-film with the energy beam while moving said substrate in a linear second direction crossing the first direction, and

wherein the energy beam is selected from the group consisting of a laser beam and an electron beam.

35. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and emitting the ion beam to the target surface of said substrate from said ion source over a length, in a first direction, of the target surface prior to a step of forming said pre-film by said film forming device to form the pre-film which has a microcrystalline nucleus layer of silicon on a boundary with respect to said substrate in said step of forming the pre-film;

forming the pre-film having said microcrystalline nucleus layer on the target surface over the length in a the first direction, the target surface having been irradiated with the ion beam by said film forming device; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam over the length in said first direction for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film while moving the substrate in a linear second direction crossing the first direction;

wherein the method is conducted without dehydrogenation processing, and

wherein the energy beam is selected from the group consisting of a laser beam and an electron beam.

36. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and emitting the ion beam to the target surface of said substrate from said ion source over a length, in a first direction, of the target surface prior to a step of forming said pre-film by said film forming device to form the pre-film which has a microcrystalline nucleus layer of silicon on a boundary with respect to said substrate in said step of forming the pre-film;

forming the pre-film having said microcrystalline nucleus layer on the target surface irradiated with the ion beam by said film forming device; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film,

wherein said film forming device employs such a structure that can form said pre-film over a the length, in the first direction, of the target surface of said substrate, said energy beam irradiation device employs such a structure that can irradiate the target surface of said substrate over the length in the first direction with the energy beam, and the intended crystalline silicon film can be successively formed by operating said film forming device to form said pre-film on the target surface of said substrate, and concurrently operating said energy beam irradiation device to irradiate the formed pre-film with the energy beam while moving said substrate in a linear second direction crossing the first direction, and

wherein the energy beam is selected from the group consisting of a laser beam and an electron beam.

37. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and forming the pre-film of the crystalline silicon film on the target surface of said substrate over a length, in a first direction, of the target surface by said film forming device wherein the ion beam is emitted to the target surface of said substrate from said ion source over the length in the first direction in an initial stage of said step of forming said pre-film to form the pre-film having a microcrystalline nucleus layer of silicon on a boundary with respect to the substrate; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam over the length in the first direction for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film while moving the substrate in a linear second direction crossing the first direction;

wherein the method is conducted without dehydrogenation processing, and

wherein the energy beam is selected from the group consisting of a laser beam and an electron beam.

38. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and forming the pre-film of the crystalline silicon film on the target surface of said substrate over a length, in a first direction, of the target surface by said film forming device wherein the ion beam is emitted to the target surface of said substrate from said ion source over the length in the first direction in an initial stage of said step of forming said pre-film to form the pre-film having a microcrystalline nucleus layer of silicon on a boundary with respect to the substrate; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam over the length in the first direction for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film,

wherein said film forming device employs such a structure that can form said pre-film over a the length, in a the first direction, of the target surface of said substrate, said energy beam irradiation device employs such a structure that can irradiate the target surface of said substrate over the length in the first direction with the energy beam, and the intended crystalline silicon film can be successively formed by operating said film forming device to form said pre-film on the target surface of said substrate, and concurrently operating said energy beam irradiation device to irradiate the formed pre-film with the energy beam while moving said substrate in a linear second direction crossing the first direction, and

wherein the energy beam is selected from the group consisting of a laser beam and an electron beam.

39. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and forming the pre-film of the crystalline silicon film on the target surface of said substrate over a length, in a first direction, of the target surface by said film forming device wherein the ion beam is emitted to the target surface of said substrate over the length in the first direction from said ion source during a period from a stage before said pre-film forming step of forming said pre-film by said film forming device to an initial stage of said pre-film forming step to form the pre-film having a microcrystalline nucleus layer on a boundary with respect to the substrate; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam over the length in the first direction for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film while moving the substrate in a linear second direction crossing the first direction;

wherein the method is conducted without dehydrogenation processing.

40. (Currently Amended) A crystalline silicon film forming method comprising the steps of:

preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, an ion source for emitting an ion beam to the target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and forming the pre-film of the crystalline silicon film on the target surface of said substrate over the length, in a first direction, of the target surface by said film forming device wherein the ion beam is emitted to the target surface of said substrate from said ion source over the length in the first direction during a period from a stage before said pre-film forming step of forming said pre-film by said film forming device to an initial stage of said pre-film forming step to form the pre-film having a microcrystalline nucleus layer on a boundary with respect to the substrate; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam over the length in the first direction for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film,

wherein said film forming device employs such a structure that can form said pre-film over a the length, in the first direction, of the target surface of said substrate, said energy beam irradiation device employs such a structure that can irradiate the target

surface of said substrate over the length in the first direction with the energy beam, and the intended crystalline silicon film can be successively formed by operating said film forming device to form said pre-film on the target surface of said substrate, and concurrently operating said energy beam irradiation device to irradiate the formed pre-film with the energy beam while moving said substrate in a second linear direction crossing the first direction.

41. (Previously Presented) The crystalline silicon film forming method according to claim 34, wherein an emission energy of said ion beam is in a range from 100eV to 1keV.

42. (Previously Presented) The crystalline silicon film forming method according claim 36, wherein an emission energy of said ion beam is in a range from 500eV to 10keV.

43. (Previously Presented) The crystalline silicon film forming method according to claim 38, wherein an emission energy of said ion beam is in a range from 500eV to 10keV.

44. (Previously Presented) The crystalline silicon film forming method according to claim 38, wherein an emission energy of said ion beam is in a range from 2keV to 10keV.

45. (Previously Presented) The crystalline silicon film forming method according to claim 39, wherein an emission energy of said ion beam is in range from 500eV to 10keV.